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Technical Report

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Charging management;

Study on Charging Aspects of Network Slicing;

(Release 16)

** 

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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

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z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, certain modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" shall not to be used as substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The present document studies the charging aspects of network slicing based on TS 23.501 [201], TS 23.502 [202], TS 28.541 [221], TS 28.530 [203] and TS 28.531 [204] Release15 specifications:

- Charging scenarios and potential requirements for different business and service model (e.g. B2B Services, NSaaS) using network slice.

- The possible charging aspects for network slice management, including the impact on charging architecture charging function and charging procedures.

The stage 1 requirements from TS 22.261 [102] Release 15 and the open issues on network slicing topic that are for further study in TR 32.899 [60] also are considered in this study.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 32.240: "Telecommunication management; Charging management; Charging architecture and principles".

[2] - [14] Void.

[15] 3GPP TS 32.255: "Telecommunication management; Charging management; 5G data connectivity domain charging; Stage 2".

[16] - [59] Void.

[60] 3GPP TR 32.899: "Telecommunication management; Charging management; Study on charging aspects of 5G system architecture phase 1".

[61] - [99] Void.

[100] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[101] Void.

[102] 3GPP TS 22.261: "Service requirements for next generation new services and markets; Stage 1".

[103] - [200] Void.

[201] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[202] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[203] 3GPP TS 28.530: "Management and orchestration; Concepts, use cases and requirements".

[204] 3GPP TS 28.531: "Management and orchestration; Provisioning".

[205] Void.

[206] 3GPP TS 28.533: "Management and orchestration; Architecture framework".

[207] - [220] Void.

[221] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".

[222] - [229] Void.

[230] 3GPP TS 28.550: "Management and orchestration; Performance assurance".

[231] Void.

[232] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[233] Void.

[234] 3GPP TS 28.554: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)".

[235] - [239] Void.

[240] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[241] - [250] Void.

[251] 3GPP TR 28.805: "Study on management aspects of communication services".

[252] - [299] Void.

[300] ITU-T Recommendation Y.3103: "Business role-based models in IMT-2020".

[301] - [499] Void.

[500] GSMA NG. 116: "Generic Network Slice Template".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in 3GPP TR 21.905 [100] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [100].

**Network Slice:** A logical network that provides specific network capabilities and network characteristics.

**Network Slice instance:** A set of Network Function instances and the required resources (e.g. compute, storage and networking resources) which form a deployed Network Slice.

**private slice**: a dedicated network slice deployment for the sole use by a specific 3rd party.

## 3.2 Symbols

Void.

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [100] and the following apply.   
An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [100].

CSC Communication Service Customer

CSP Communication Service Provider

DN Data Network

IOC Information Object Class

KPI Key Performance Indicators

MNO Mobile Network Operator

NOP Network Operator

NRM Network Resource Model

NSaaS Network Slice as a Service

NSMF Network Slice Management Function

NSMS Network Slice Management Service

NSaaS Network Slice as a Service

NSI Network Slice Instance

NSS Network Slice Subnet

NSSI Network Slice Subnet Instance

NWDAF Network Data Analytics Function

# 4 Concepts and background

## 4.0 General Description

Usually, network slice is considered to be a composition of network functions to offer communication services with particular network characteristics (e.g. Coverage, UE Mobility Level, Sharing Level, QoS etc.), as specified in TS 22.261 v15.6.0 [102] and TS 28.541 v15.1.0 [221].

Network slices may be configured and instantiated on a service-specific basis. Network Operator can instantiate network slices dedicated to various IoT services with different requirements, for example, low-consumption devices (e.g. temperature sensors), versus high-consumption devices(e.g. Real-time street traffic management). Each of these services may require different requirements for bandwidth, latency, control, service assurance.

Network slices may be specific to the needs of an organization, such as a large enterprise, university or research institution. For example, an electric power enterprise may have different requirement on network slice (e.g. Industrial control services, Information collection services and Remote inspection of Unmanned aerial vehicle).

Network slices can also be specific to special events that take place across particular geographies during a specific period of time, for example, concert, sports events.

## 4.1 Background

### 4.1.1 Network Slice Lifecycle

As per the clause 4.3 Management aspects of a network slice instance in TS 28.530 v15.1.0 [203], there are 4 phases in the lifecycle of a Network Slice Instance, which are summarized as the following.

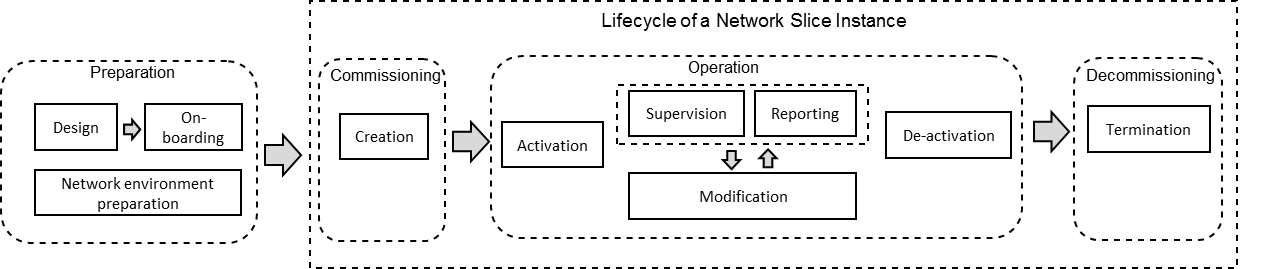


Figure 4.1.1-1: An example of deployment scenario for management of a mobile network including network slicing

**Preparation phase:** Network slice template design, network slice capacity planning, on-boarding and, evaluation of the network slice requirements, preparing the network environment and other necessary preparations required to be done before the creation of an NSI.

**Commissioning phase:** All needed resources are allocated and configured to satisfy the network slice requirements. The creation of an NSI can include creation and/or modification of the NSI constituents.

**Operation phase:**

**Activation:** Activation makes the NSI ready to support communication services.

**De-activation:** Making the NSI inactive and stops the communication services.

**Decommissioning phase:** Decommissioning of non-shared constituents if required and removing the NSI specific configuration from the shared constituents.

### 4.1.2 Network Slice Management

5G system consists of 5G Access Network (AN), 5G Core Network and UE, see TS 23.501 v15.4.0 [201].

The Management Services and Management Function (MnF) concept are part of the management framework for 3GPP 5G system which is specified in TS 28.533 [206]. A Mnf plays the role of either Management Service (MnS) producer or Management Service (MnS) consumer.

Different examples of deployment models for Network Slice Management are provided in this TS 28.533 [206]:

Annex A.1 provides an example of layered management model with the network and network slice management layer which comprises a Network slice management function:

- producing Management services for consumers;

- consuming Management services produced by lower layer including network slice subnet management function.

Annex A.6 provides an example of management architecture with functional blocks, which is composed of MnFs producing and consuming Management services: the Network Slice Management Function (NSMF) producing management services for one or more NSI, and the Communication Service Management Function (CSMF) consuming management service(s) produced by other functional blocks.

Annex A.8 provides an example of deployment scenario for network and network slice, with Management Services (MnS) produced and consumed by different MnFs located at different levels. The Network and Network Slice Management Function produces the management services for network or NSI to the Consumer, and consumes management services produced by RAN, CN Management Functions.

The Network Slice Management, relying on this 3GPP management framework, can be considered under two main models as per TS 28.530 [203]:

- Network Slice as NOP model: the NOP is the network slice provider, the CSP is the network slice customer.

- Network Slice as a Service (NSaaS): the CSP is the network slice provider and the CSC is the network slice customer. This belongs to Business to business (B2B).

## 4.2 Business Roles related to network slicing charging

As per the TS 28.530 v15.1.0 [203], in the context of next generation networks, responsibilities regarding operations have to be clearly defined and assigned to roles. The roles related to 5G networks and network slicing management include:

- Communication Service Customer (CSC): Uses communication services.

- Communication Service Provider (CSP): Provides communication services.

- Network Operator (NOP): Provides network services.

- Virtualization Infrastructure Service Provider (VISP): Provides virtualized infrastructure services.

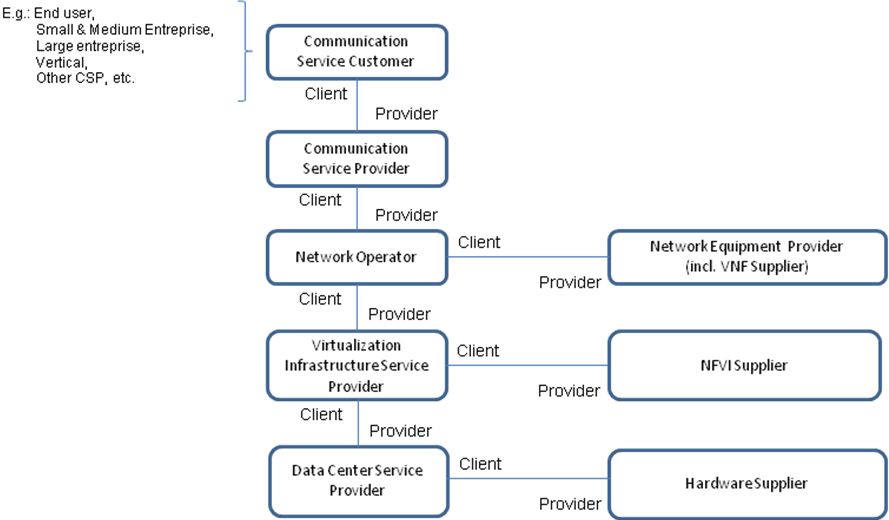


Figure 4.2-1: High-level model of roles

The NOP can provide the network slice instance to the CSP as the charging party. Corresponding, the CSP can consume the network slice instance as the charged party.

Different business roles from network slicing perspective are introduced by ITU-T Recommendation Y.3103 [300]. The interactions between two business roles across their interface are subject to billing settlements based on corresponding service level agreements (SLA). In order to allow the billing settlements, charging capabilities have to be considered for addressing each business interface.

In the present document, the following sub-set of business roles are considered:

- Network slice service user: uses the service(s) provided by the NSI(s).

- Network slice service provider: user of the NSI(s)) and is responsible for providing services to its NS service users via the NSI(s).

- Network slice provider: owner of the NSI(s) and provides the NSI (s).

The Network slice management and orchestration provider role is not considered as separate from providers and Orchestration of NS(s) is out of scope.

The business interface between the Network slice service provider (charged party) and the Network slice provider (charging party), is considered for charging capabilities related to:

- NSI(s) usage.

- NSI(s) Management.

The figure 4.2-2 shows a simplified view of business interface with Network slice service provider and Network slice provider business roles.



Figure 4.2-2: Simplified view of Network slice service provider and Network slice provider business roles

In this diagram, the Network slice service user business role, as well as its business interface with the Network slice service provider are mentioned for illustration purpose.

The business interface between the Network slice service user (charged party) and the Network slice service provider (charging party), is also considered for the particular case where the service used by Network slice service user and offered by Network slice service provider is a Network Slice (NSaaS). Charging capabilities for this case relate to NSI(s) Management.

The figure 4.2-3 shows a simplified view of business interface for NSaaS



Figure 4.2-3: Simplified view of business interface for NSaaS

The set of models and best practice use cases in ITU-T Recommendation Y.3103 [300] are described with players combining multiple business roles.

Models which are those covered by the present document are those where Network slice service provider and the Network slice provider are separate players.

The Figures 4.2-2 and 4.2-3 can be used with terminology from TS 28.530 [203] where:

- The Communication Service Customer (CSC) is the Network slice service user.

- The Communication Service Provider (CSP) is the Network slice service provider.

- The Network Operator (NOP) is the Network slice provider.

## 4.3 Charging aspect requirement

As per the charging aspect requirements specified in TS 22.261 v15.6.0 [102], the requirement related Network slice are present as following.

* *"The 5G core network shall support collection of all charging information on either a network or a slice basis."*
* *"The 5G core network shall support collection of charging information based on the slice that the UE accesses."*
* *"The 5G core network shall support collection of charging information based on the capacity and performance metrics."*

# 5 Topics

## 5.1 Topic 1: Business to Business - Network Slice usage

### 5.1.1 Use Case

#### 5.1.1.1 Use Case #1.1: CSP consumes a private slice

The NOP provides private slice service to satisfy CSP’s requirements.

A CSP needs a performance-guaranteed private slice to deliver its service, and subscribes a private network slice instance from the NOP, based on network slice’s performance data (e.g. latency) and/or usage (e.g. volume, duration, number of connections).

Based on the subscription, during the operation phase, the NOP creates/activates a new NSI or allocates existing NSI for the sole use by the CSP and then starts collection of charging information. The NOP enables the private NSI charging information collection based on subscription. If measurement method is usage, the NOP collects the NSI usage for CSP. If measurement method is performance data, the NOP collects performance data.

Based on the subscription and collection, the NOP records and reports the NSI charging information.

The NOP (Network Operator) is the network slice provider, the CSP is the network slice customer.

The potential charging requirements for this UC are: REQ-3GPPCH-01, REQ-3GPPCH-02

#### 5.1.1.2 Use Case #1.2: CSP consumes a shared network slice instance

The NOP provides network slice service to satisfy CSP’s requirements.

A CSP needs a performance-guaranteed network slice to deliver its service, and subscribes a network slice instance from the NOP based on network slice’s performance data (e.g. latency) and/or usage (e.g. volume, duration, number of connections).

Based on the subscription, during the operation phase, the NOP creates/activates a new NSI or allocates existing NSI. The NOP starts the collection of charging information and enables the NSI charging information collection based on subscription and actual usage. If measurement method is usage, the NOP collects the NSI usage for CSP. If measurement method is performance data, the NOP collects performance data.

Based on the subscription and collection, the NOP records and report the shared NSI charging information per CSP.

The NOP (Network Operator) is the network slice provider, the CSP is the network slice customer.

The potential charging requirements for this UC are: REQ-3GPPCH-03, REQ-3GPPCH-04.

#### 5.1.1.3 Use Case #1.3: CSP consumes multiple network slice instances

The NOP provides network slice service to satisfy CSP’s requirements.

A CSP needs multiple performance-guaranteed network slices to deliver its service, and subscribes to multiple private/shared network slice instances from the NOP based on network slice’s performance data (e.g. latency) and/or usage (e.g. volume, duration, number of connections).

Based on the subscription, during the operation phase, the NOP creates/activates multiple new NSIs or allocates existing NSIs. For each NSI, the NOP starts collection of charging information and enables charging information collection based on subscription and actual usage. If measurement method is usage, the NOP collects the network slice’s usage for CSP. If measurement method is performance data, the NOP collects performance data.

Based on the subscription and collection, the NOP records, reports the NSI charging information and then aggregates the charging information for CSP.

The NOP (Network Operator) is the network slice provider, the CSP is the network slice customer.

The potential charging requirements for this UC are: REQ-3GPPCH-01, REQ-3GPPCH-02, REQ-3GPPCH-03, REQ-3GPPCH-04, REQ-3GPPCH-05

#### 5.1.1.4 Use Case #1.4: CSP subscribes the Network Slice Instances

The NOP provides network slice services subscription to satisfy CSP’s requirements.

A CSP decides to deliver a service using a network slice instance. The characteristics of a network slice instance are defined by a set of attributes. The CSP subscribes to the NOP for a network slice instance with specified attributes e.g. performance guarantee, coverage, energy efficiency, reliability, supported traffic types, supported access technologies.

Based on the customized requirements from the CSPs, the NOP provides the network slice instances with different network slice characteristics (e.g. eMBB, IoT and automatic driver) described under attributes and during the operation phase, the operator creates/activates a new NSI or allocates existing NSI and then starts collection charging information with the customized slice attributes (e.g. latency).

Based on the customized requirements from the CSPs, the operator records and reports the customized NSI charging information.

The NOP is the network slice provider, the CSP is the network slice customer.

The potential charging requirements for this Use Case are: REQ-3GPPCH-06, REQ-3GPPCH-08.

#### 5.1.1.5 Use Case #1.5: CSP consumes a network slice instance under the usage limit

A CSP needs one or more network slice instances to deliver its service. A CSP will need a subscription from the Operator with a limit for the network slices usage.

During the operation phase, the operator creates/activates new NSI(s) or allocates existing NSI(s) to the CSP. The operator collects charging information of the NSI(s), and performs usage limit control for the NSI(s). When usage limit reached, operator perform action based on the subscription, e.g. notify the CSP or reduce the bandwidth.

The NOP (Network Operator) is the network slice provider, the CSP is the network slice customer.

The potential charging requirement for this UC is: REQ-3GPPCH-07.

### 5.1.2 Potential charging requirements

**REQ-3GPPCH-01** The 5G system should support collecting charging information of performance metrics of private slice instances.

**REQ-3GPPCH-02** The 5G system should support collecting charging information of CSP’s usage of private slice instances.

**REQ-3GPPCH-03** The 5G system should support collecting charging information of performance metrics of shared slice instances.

**REQ-3GPPCH-04** The 5G system should support collecting charging information of CSP’s usage of shared slice instances.

**REQ-3GPPCH-05** The 5G system should support aggregation of charging information of multiple CSP’s slice instances.

**REQ-3GPPCH-06** The 5G system should support customized charging information collection of performance metrics based on different network slice instance charging requirements.

**REQ-3GPPCH-07** The 5G system should support the usage limit control per CSP of network slice instances.

**REQ-3GPPCH-08** The 5G system should support customized charging information collection considering template terminology as defined in clause 4.5 of TS 28.531 [204].

The present document will focus on the study the key issue and solutions based on the charging requirements in clause 4.3 and the potential charging requirements for the use cases.

### 5.1.3 Key issues

#### 5.1.3.1 Key issue #1.1: Performance based charging

This key issue is for investigating how to support the performance based charging for network slice instances considering REQ-3GPPCH-01, REQ-3GPPCH-03 and REQ-3GPPCH-06.

This investigation covers the following:

- identification and classification of the main performance indicators for network slice instance charging;

- determination of which entity/entities in the 5G system are suitable to provide the performance indicators;

- determination of the interactions required to obtain performance indicators for network slice instance charging.

#### 5.1.3.2 Key issue #1.2: Usage based charging

This key issue is for investigating how to support the usage based charging for network slice considering REQ-3GPPCH-02, REQ-3GPPCH-04 and REQ-3GPPCH-05.

This investigation covers the following:

- identification of the usage type used for network slice instance charging;

- determination of which entity/entities in the 5G system is suitable to provide the usage information;

- determination of the main interactions to obtain the usage;

- how to perform usage limit control based on subscription for NSI(s) user.

#### 5.1.3.3 Key issue #1.3: Network slice template based charging

This key issue is to investigate how to support charging for network slice instances when the network slice templates are used in the 5G system as described in TS 28.531 [204] and GSMA NG. 116: "Generic Network Slice Template" [500]. The following requirements will be considered: REQ-3GPPCH-01, REQ-3GPPCH-03, REQ-3GPPCH-06, REQ-3GPPCH-08 and REQ-3GPPCH-09.

This investigation covers the following:

- identification and classification of the set of attributes that can uniquely characterise a type of network slice within a template that are relevant for network slice instance charging;

- determination of which entity/entities in the 5G system are suitable to provide data relating to the set of attributes that can characterise a type of network slice within a template;

- determination of the interactions required to obtain the template related data for network slice instance charging.

### 5.1.4 Solutions

#### 5.1.4.1 Solution #1.1: Network Slice Instance Performance based charging for Key issues #1.1

##### 5.1.4.1.1 Consideration for Network Slice Instance Performance Based Charging

The following performance data for 5G Network slice may be used to enable network slice instance charging for example:

- Latency.

- Reliability.

- Upstream /Downstream Throughput for Single Network Slice Instance.

- Mean number of PDU sessions of network Slice Instance.

- Registered Subscribers of network Slice Instance.

- Mobility related measurements.

- Overall user density / simultaneous connected devices, etc.

NOTE: The performance data are specified in OAM specifications TS 28.552[232] and TS 28.554[234].

One or more these performance data may be used for network slice instance charging based on the SLA (service-level agreement) between CSP and NOP.

According to the lifecycle of network slice instances and network slice high-level architecture in TS 28.530 v15.1.0 [203], the network slice management system has the capability to collect and provide the performance data of NSI(s), as the NS charging information provider.

##### 5.1.4.1.2 Architecture Description

5.1.4.1.2.1 Performance based Network Slice Instance Charging Function

To leverage the capabilities of network slice management system, the enhancement of Converged Charging System for Network slice performance based charging is proposed:



Figure 5.1.4.1.2.1-1: Enhancement of Converged Charging System for Network slice

The NSI charging information provider is the service producer; the Performance based Network Slice Instances Charging Function in CCS is the service consumer. The Performance based Network Slice Instances Charging Function takes charge of requesting performance data based on agreement and creates the performance data CDR. The Performance Management services specified in TS 28.550 [230] can be used for acquiring the performance data.

This is based on management architecture for 3GPP 5G system specified in TS 28.533 [206]: the Management Function is a MnF playing the role of MnS producer and the Performance based Network Slice Instances Charging Function is the MnS consumer.

Online charging is not applied for performance based charging of network slice instances.

5.1.4.1.2.2 Management Function - NSMF

The following figure 5.1.4.1.2.2-1 shows Performance based Network Slice Instances Charging Function consumer of MnS service in the TS 28.533[206] management architecture:



Figure 5.1.4.1.2.2-1: Performance based Network Slice Instances Charging Function consumer of MnS service

The NSMF is the Producer of Network Slice Performance Management Service.

##### 5.1.4.1.3 Flow Description

The figure 5.1.4.1.3-1 describes the high level charging procedure for network slice instance in solution 5.1.4.1.2.1.



Figure 5.1.4.1.3-1: Charging procedure for NSI

1. The Performance based Network Slice Instance Charging Function decides the charging start based on subscription.

2. The Performance based Network Slice Instance Charging Function sends the subscription request to Management Function based on agreement.

3. The Management Function response with the successful subscription.

4. Management Function sends the notify request to Performance based Network Slice Instance Charging Function.

5. Performance based Network Slice Instance Charging Function acknowledges the notification.

6. Performance based Network Slice Instance Charging Function unsubscribes the subscription.

7. Management Function responses the successful un-subscription.

The procedure uses the "Subscribe-notify" paradigm of management framework for 3GPP 5G system which is specified in TS 28.533[206] in clause 5.1.2.

##### 5.1.4.1.4 Solution evaluation

For this solution the advantages are:

- Different customers can have flexible and personalized network slice instance performance indicators, these can be dedicated for charging or common with other management.

- No major change on 3GPP management functions, since they can allow authorized NF consumer to request collection of performance data for NSI(s), i.e. the CHF can subscribe using available services.

- No impact on the CHF as it does not need to be a consumer as well as a producer of services, except for the services provided by NRF.

And the disadvantages are:

- A new NF needs to be introduced as a consumer.

- The charging cannot directly influence the provided service, i.e. it cannot grant or deny service access.

#### 5.1.4.2 Solution #1.2: Usage reporting for Key issues #1.2

##### 5.1.4.2.1 Consideration for usage based charging

Network Slice Instance related usage type may include following:

- volume;

- duration (per PDU session).

NOP may perform charging for CSP based on usage information of above unit type.

According to the SMF capabilities in TS 32.255 v15.1.0 [15], the SMF can collect and provide the above charging information per PDU session of NSI(s). Therefore, the SMF can act as CTF for usage based charging.

##### 5.1.4.2.2 Architecture Description

The converged online and offline charging architecture is adapted for the usage based charging for network slice instances.



Figure 5.1.4.2.2-1: The Converged Charging System

The SMF is responsible for reporting the usage information of network slice instances for session based charging per PDU session.

In order to support the charging per network slice instance for CSP, the SMF reports the charging information with the S-NSSAIto identify the network slice instance, the Subscriber Identifier and the start timestamp of PDU session to charging system for aggregating the usage information of network slice instance.

##### 5.1.4.2.3 Flow Description

The figure 5.1.4.2.3-1 describes the high level charging procedure for usage based charging, which is the same with the operation between SMF and CHF in release 15.



Figure 5.1.4.2.3-1: Charging procedure for usage based charging

1. The SMF collects the charging information of network slice instance.

2. The SMF reports the usage information, including the S-NSSAI, Subscriber Identifier and the start timestamp of PDU session start.

3. CHF sends the charging data response.

4. CHF includes network slice instance information in the CDR to enable aggregation in the billing domain (e.g. a post-processing system or a mediation device).

##### 5.1.4.2.4 Solution evaluation

For this solution the advantages are:

- No change on SMF, i.e. the current Nchf can be reused.

- No major impact on the Converged Charging System architecture i.e. no new NF is added

- The CHF can directly influence the provided service, i.e. it can grant or deny service access.

And the disadvantages are:

- Session based signalling is usually more intensive than event based.

#### 5.1.4.3 Solution #1.3: Event Based Charging for Key issues #1.2

##### 5.1.4.3.1 Consideration for event based charging

Network slice related usage type as chargeable information (e.g. the number of IoT connections) only includes following:

- number of PDU session.

NOP may perform charging for CSP based on usage information of above unit type.

As per the description of SMF capabilities in TS 32.255 v15.1.0 [15], the enhancement of SMF supports the event based charging is proposed.

In this scenario, the charging session is not needed, an event based charging is assumed.

##### 5.1.4.3.2 Architecture Description

The converged online and offline charging architecture is adapted for the event based charging for network slice, as the clause 5.1.4.2.2.

The SMF is responsible for reporting the usage information of network slice for event based charging per PDU session.

In order to support the event based charging per network slice for CSP, the SMF reports the charging information with the S-NSSAIto identify the network slice instance and the Subscriber Identifier to charging system for aggregating the usage information of network slice instance.

##### 5.1.4.3.3 Flow Description

The figure 5.1.4. 3.3-1 describes the high level charging procedure for event based charging, which is the enhancement of the operation between SMF and CHF in release 15.



Figure 5.1.4.3.3-1: Charging procedure for Event based charging

1. Based on the configuration or PCC rule, start of PDU session charging event triggers the event based charging and SMF collects the charging information of network slice when new PDU session is created.

2. The SMF reports the usage information with ChargingDataRequest [Event], including the S-NSSAI, Subscriber Identifier.

3. CHF sends the ChargingDataResponse [Event].

4. CHF includes network slice instance information in the CDR to enable aggregation in the billing domain (e.g. a post-processing system or a mediation device).

##### 5.1.4.3.4 Solution evaluation

For this solution the advantages are:

- No major impact on the Converged Charging System architecture i.e. no new NF is added

- Event based signalling can be less intensive than session based.

And the disadvantages are:

- The CHF cannot directly influence the provided service, i.e. it cannot grant or deny service access.

- Change on SMF required, i.e. the current Nchf needs to be updated for SMF.

#### 5.1.4.4 Solution #1.4: Network Slice Instance Performance based charging for Key issues #1.1

##### 5.1.4.4.1 Consideration for Network Slice Instance Performance Based Charging

See clause 5.1.4.1.1.

##### 5.1.4.4.2 Architecture Description

5.1.4.4.2.1 CHF consumer on MnS

To leverage the capabilities of network slice management system, the CHF is proposed to be a consumer of the interface provided by the 3GPP Management Function.



Figure 5.1.4.4.2-1: CHF as producer of Nchf and consumer of the Management Service (MnS)

The Management Function is the producer of the MnS which is consumed by the CHF in order to do charging based on performance and configuration of a Network Slice. Since there is currently no granting of units available on the MnS it means that no quota management can be performed for the network slice in this solution, it would instead rely on a subscription and notification for the collection of the relevant charging information. The Performance Management services specified in TS 28.550 [230] can be used for acquiring the performance data.

This is based on management architecture for 3GPP 5G system specified in TS 28.533 [206]: the Management Function is a MnF playing the role of MnS producer and the CHF is the MnS consumer.

5.1.4.4.2.2 Management Function - NSMF

The following figure 5.1.4.4.2-1 shows CHF consumer of MnS service in the TS 28.533 [206] management architecture, with a layered approach:



Figure 5.1.4.4.2.2-1: CHF consumer of MnS service

The NSMF is the Producer of Network Slice Performance Management Service.

##### 5.1.4.4.3 Flow Description

The flow is the same as in clause 5.1.4.1.3 where the Performance based Network Slice Instance Charging Function has been replaced by CHF.

##### 5.1.4.4.4 Solution evaluation

For this solution the advantages are:

- Different customers can have flexible and personalized network slice instance performance indicators, these can be dedicated for charging or common with other management.

- No major change on 3GPP management functions, since they can allow authorized NF consumer to request collection of performance data for NSI(s), i.e. the CHF can subscribe using available services.

- No major impact on the Converged Charging System architecture i.e. no new NF is added.

And the disadvantages are:

- The CHF now needs to be a consumer as well as a producer of services, except for the services provided by NRF.

- The CHF cannot directly influence the provided service, i.e. it cannot grant or deny service access.

#### 5.1.4.5 Solution #1.5: Network Slice Instance Performance based charging for Key issues #1.1

##### 5.1.4.5.1 Consideration for Network Slice Instance Performance Based Charging

See clause 5.1.4.1.1.

##### 5.1.4.5.2 Architecture Description

5.1.4.5.2.1 Performance based Network Slice Charging Function

This solution is based on the location of a Charging Trigger Function (CTF) within the Network Slice Instance lifecycle management functionality of the Management Function.



Figure 5.1.4.5.2-1: CTF of the Management Function interacts with Converged Charging System using Nchf interface for performance charging.

A charging service is exposed on Nchf by CHF and consumed by the Management Function.

The PM services specified in TS 28.550 [230] can be used for acquiring the performance data.

##### 5.1.4.5.3 Flow Description

The flow is the same as in clause 5.1.4.2.3 where the SMF has been replaced by the Management Function.

##### 5.1.4.5.4 Solution evaluation

For this solution the advantages are:

- Different customers can have flexible and personalized network slice instance charging.

- The CHF do not need to be a consumer as well as a producer of services, except for the services provided by NRF.

- The CHF can directly influence the provided service, i.e. it can grant or deny service access.

- No major impact on the Converged Charging System architecture i.e. no new NF or service is added.

And the disadvantages are:

- Personalized network slice instance performance indicators for other management cannot be reused by charging.

- Superfluous information may be sent to CHF in order to provide the needed flexibility and personalization possibilities.

- Major change on 3GPP management functions, since they need to support the Nchf service.

#### 5.1.4.6 Solution #1.6: Usage reporting for Key issues #1.2

##### 5.1.4.6.1 Consideration for usage limit for CSP

A CSP can subscribe one or more private/shared NSI(s). For CSP’s usage limit control, the following cases are taken into account.

- Case 1: CSP subscribes the private slice instances and the all PDU sessions in the private slice instances belongs to the CSP.

- Case 2: CSP subscribes the shared slice instances and the dedicated PDU sessions in the shared slice instances belongs to the CSP.

- Case 3: CSP subscribes the shared slice instances and the partial SDFs of PDU session in the shared slice instances belong to the CSP.

Network Slice Instance related usage type may include following:

- volume;

- number of PDU sessions.

NOP may perform usage limit of above unit type for CSP.

##### 5.1.4.6.2 Architecture Description

The converged online and offline charging architecture is adapted for usage limit for CSP.



Figure 5.1.4.6.2-1: The Converged Charging System

The solutions are based on the CHF selection mechanism specified in TS 32.255 [15]. The SMF performs usage limit control per PDU session in each NSI.

- For case 1, the CHF addresses can be provided for PDU sessions in private slice instance and charging information of the CSP is routed to the same CHF which performs the usage limit control.

- For case 2, the CHF addressed can be provided based on the PDU sessions. The charging information associated to the usage of same CSP’s PDU sessions can be routed to the same CHF to perform the usage limit control of CSP.

- For case 3, the solution is out of scope.

##### 5.1.4.6.3 Flow Description

The figure 5.1.4.6.3-1 describes the high level charging procedure for case 1 and 2.



Figure 5.1.4.6.3-1: Charging procedure for case 1 and 2

1. The SMF determines CHF address for PDU session.

2. The SMF sends usage information and requested quota to CHF.

3. CHF performs quota management for CSP’s usage limit.

4. CHF sends granted quota for the PDU session to the SMF.

##### 5.1.4.6.4 Solution evaluation

In this solution, there is no impact on existing Nchf between SMF and CHF.

#### 5.1.4.7 Solution #1.7: Network Slice Instance Analytics based charging for Key issues #1.1

##### 5.1.4.7.1 Consideration for Network Slice Instance Analytics Based Charging

The following information related to 5G Network slice may be used to enable network slice instance charging:

- Load level

This information may be used for network slice instance charging based on the SLA (service-level agreement) between CSP and NOP.

NOTE: which data may be used for network slice instance analytics charging will be determined during the normative work and load level is candidate to be one of them.

##### 5.1.4.7.2 Architecture Description

To leverage the capabilities of NWDAF offering Slice load level related network data analytics, the CHF is proposed to be a consumer of the service provided by the NWDAF:



Figure 5.1.4.7.2-1: CHF as producer of Nchf and consumer of the NWDAF (Nnwdaf)

The NWDAF is the producer of Analytics service over Nnwdaf which is consumed by the CHF in order to do charging based on load level of a Network Slice.

The NWDAF and its services are specified in TS 23.288 [240]: they can be used when specified for acquiring Slice load level analytics.

##### 5.1.4.7.3 Flow Description

The figure 5.1.4.7.3-1 describes the high level charging procedure for Analytics based network slice instance:



Figure 5.1.4.7.3-1: Charging procedure for NSI

1. Charging starts based on subscription.

2. CHF subscribes to subscription to analytics information by invoking the Nnwdaf\_AnalyticsSubscription\_Subscribe service, indicating load level information for a specific NSI.

3. The NWDAF notifies the CHF with the Slice load level analytics information by invoking Nnwdaf\_AnalyticsSubscription\_Notify service

4. Charging stops based on subscription

5. CHF unsubscribes to Slice load level analytics information by invoking the Nnwdaf\_AnalyticsSubscription\_Unsubscribe service.

##### 5.1.4.7.4 Solution evaluation

For this solution the advantages are:

- Different customers can have flexible and personalized network slice instance Load level/ Threshold performance indicators, these can be dedicated for charging.

- No change on NWDAF, since they can allow CHF as an authorized NF consumer, to subscribe to Slice load level related network data analytics, when they are specified.

- No major impact on the Converged Charging System architecture i.e. no new NF is added.

- Other Analytics beyond the Slice load level could be subscribed-to by CHF in the future.

And the disadvantages are:

- The CHF now needs to be a consumer as well as a producer of services, except for the services provided by NRF.

- The CHF cannot directly influence the provided service, i.e. it cannot grant or deny service access.

- Additional NF (i.e. NWDAF) for CHF to consume service(s) from.

#### 5.1.4.8 Solution #1.8: Network Slice Instance Performance based charging for Key issues #1.1

##### 5.1.4.8.1 Consideration for Network Slice Instance Performance Based Charging

See clause 5.1.4.1.1.

##### 5.1.4.8.2 Architecture Description

5.1.4.8.2.1 Network Slice Charging Trigger Function

This solution is based on the location of a CTF within a new Network Slice Charging Trigger Function.

The following figure 5.1.4.8.2.1-1 shows the Network Slice Charging Trigger Function and the CHF in the TS 28.533[206] management architecture:



Figure 5.1.4.8.2.1-1: Network Slice Charging Trigger Function using Nchf interface for performance charging.

A charging service is exposed on Nchf by CHF and consumed by the Network Slice Charging Trigger Function.

The NSMF is the Producer of Network Slice Performance Management Service.

The Network Slice Charging Trigger Function is the MnS consumer of Network Slice Performance Management Service.

##### 5.1.4.8.3 Flow Description

The flow is the same as in clause 5.1.4.2.3 where the SMF has been replaced by the Network Slice Charging Trigger Function.

##### 5.1.4.8.4 Solution evaluation

For this solution the advantages are:

- Different customers can have flexible and personalized network slice instance charging.

- The CHF do not need to be a consumer as well as a producer of services, except for the services provided by NRF.

- The CHF can directly influence the provided service, i.e. it can grant or deny service access.

- No major impact on the Converged Charging System architecture i.e. no new NF or service is added.

And the disadvantages are:

- Personalized network slice instance performance indicators for other management cannot be reused by charging.

- Superfluous information may be sent to CHF in order to provide the needed flexibility and personalization possibilities.

- A new Network Slice Charging Trigger Function needs to be defined to support consumption of PM service as well the Nchf service.

#### 5.1.4.9 Solution #1.9: Network Slice Instance Performance based charging for Key issues #1.1

##### 5.1.4.9.1 Consideration for Network Slice Instance Performance Based Charging

See clause 5.1.4.1.1.

##### 5.1.4.9.2 Architecture Description

To leverage the capabilities of NWDAF to collect performance measurements, the CHF can be a consumer of the service provided by the NWDAF for performance based Charging.

The Architecture is the same as Figure 5.1.4.7.2-1.

The NWDAF is the producer of Network Performance Analytics service over Nnwdaf which is consumed by the CHF in order to do charging based on Performance of a Network Slice.

The NWDAF of Network Performance Analytics service is specified in TS 23.288 [240].

##### 5.1.4.9.3 Flow Description

The flow is the same as in clause 5.1.4.7.3 where the CHF subscribes to subscription to analytics information by invocation of Nnwdaf\_AnalyticsSubscription\_Subscribe indicating " Network Performance".

##### 5.1.4.9.4 Solution evaluation

For this solution the advantages are:

- Different customers can have flexible and personalized network slice instance performance indicators, these can be dedicated for charging or common with other management.

- No change on NWDAF, since they can allow authorized NF consumer to request collection of performance data for NSI(s), i.e. the CHF can subscribe using available services.

- No change on 3GPP management functions, NWDAF is expected already to be an authorized NF consumer of OAM for collection of performance data for NSI(s), i.e. the CHF can subscribe using available services.

- No major impact on the Converged Charging System architecture i.e. no new NF is added.

- Other Analytics beyond the Performance data could be subscribed-to by CHF in the future.

And the disadvantages are:

- The CHF now needs to be a consumer as well as a producer of services, except for the services provided by NRF.

- The CHF cannot directly influence the provided service, i.e. it cannot grant or deny service access.

- Two steps to retrieve Performance data: NWDAF retrieves PM data from OAM and CHF retrieves PM data from NWDAF.

#### 5.1.4.10 Solution #1.10: Network Slice Instance Template based charging for Key issues #1.3

##### 5.1.4.10.1 Consideration for Network Slice Instance Template Based Charging

Network Slice Instance templates are a possible mechanism to assist in creating network slice instances by the 5G Management system as described in TS 28.531 [204]. The attributes that can be used within a template to characterize a network slice instance are described by the attributes of ServiceProfile in 3GPP TS 28.541 [221].

##### 5.1.4.10.2 Architecture Description

5.1.4.10.2.1 Template based Network Slice Charging Function

This solution is based on the location of a Charging Trigger Function (CTF) within the Network Slice Instance lifecycle management functionality of the Management Function.



Figure 5.1.4.10.2.1-1: CTF of the Management Function interacts with Converged Charging System using Nchf interface for template based charging.

A charging service is exposed on Nchf by CHF and consumed by the Management Function.

The Management Function creates and populates charging events based on the characteristics of a network slice instance described by a template.

##### 5.1.4.10.3 Flow Description

The flow is the same as in clause 5.1.4.2.3 where the SMF has been replaced by the Management Function.

##### 5.1.4.10.4 Solution evaluation

For this solution the advantages are:

- Different customers can have flexible and personalized network slice instance charging.

- The CHF do not need to be a consumer as well as a producer of services, except for the services provided by NRF.

- The CHF can directly influence the provided service, i.e. it can grant or deny service access.

- No major impact on the Converged Charging System architecture i.e. no new NF or service is added.

And the disadvantages are:

- Major change on 3GPP management functions, since they need to support the Nchf service.

### 5.1.5 Evaluation

#### 5.1.5.1 Solutions evaluation for Key issue #1.1

All solutions #1.1, #1.4, #1.5, #1.7 #1.8 and #1.9 solve Key issue #1.1.

In the solutions #1.1, #1.4, #1.7 and #1.9 the Converged Charging System becomes a consumer of services (beyond the services provided by NRF), which deviates from how Converged Charging System is currently designed.

The solutions #1.5 and #1.8 are futureproof from charging's perspective since they allow influence on the provided service, i.e. it cannot grant or deny service access, although this capability may not be needed for performance based charging. However, the solution #1.5 has the drawback to strongly impact 3GPP management, therefore the solution #1.8x is preferred for Performance based charging.

The solutions #1.9 and #1.7 allow the NWDAF as a new source to collect data, and benefit from analytics beyond the Performance data in the future. They are both retained for Analytics based charging.

The solutions #1.8, #1.9 and #1.7 can be combined to specify Performance and Analytics based charging.

#### 5.1.5.2 Solutions evaluation for Key issue #1.2

All solutions #1.2, #1.3 and #1.6 solve Key issue #1.2.

Solution #1.2 about network slice charging based on volume and duration (per PDU session), has no impact on existing Nchf between SMF and CHF.

Solution #1.3 about network slice charging based on the number of PDU session can be solved by existing charging mechanism (session based charging).

Solution #1.6 about network slice charging based on usage limit for CSP has no impact on existing Nchf between SMF and CHF.

#### 5.1.5.3 Solutions evaluation for Key issue #1.3

Solution #1.10 solves Key issue #1.3.

### 5.1.6 Conclusions

It is concluded on Performance and Analytics based Charging for Key issue #1.1 with:

- Solution #1.8 in clause 5.1.4.8.

- Solution #1.9 in clause 5.1.4.9.

- Solution #1.7 in clause 5.1.4.7.

It is concluded on usage based charging for Key issue # 1.2 with:

- Solution #1.2 in clause 5.1.4.2, and no further normative work.

- Solution #1.6 in clause 5.1.4.6, and no further normative work.

It is concluded that Key issue #1.3 is more relevant to topic 2 and is covered by solutions #2.1 and #2.2. Thus, there is no requirement for any normative work to address topic 1.

It is concluded that charging requirement for capacity based network slice charging described in clause 4.3 can be covered in Performance and analytics based charging.

## 5.2 Topic 2: Business to Business - Network Slice management

### 5.2.1 Use Cases

#### 5.2.1.1 Use Case #2.1: NSI provisioning – NOP model

The NOP (Network Operator) is the network slice provider, the CSP is the network slice customer.

The CSP needs to perform Network Slices management in order to offer Communication Services (e.g. eMBB services) to a CSC.

Management of Network slices by a CSP is achieved under the 4 phases in the lifecycle of a Network Slice Instance identified in clause 4.1.1:

- Preparation phase: this phase is not considered under in the present document.

- Commissioning phase: NSI creation.

- Operation phase: NSI modification, NSI Activation, De-Activation.

- Decommissioning phase: NSI termination.

Based on information received from the CSP upon NSI creation and modification, the NOP determines whether a private NSI needs to be allocated (private NSI) or an existing NSI can be re-used (shared NSI).

The NOP collects charging information for the different operations performed by the CSP on Network Slice instances.

The potential charging requirements for this Use Case are: REQ-CH-NSIMNG-01, REQ-CH-NSIMNG-02, REQ-CH-NSIMNG-03, REQ-CH-NSIMNG-04, REQ-CH-NSIMNG-05 and REQ-CH-NSIMNG-06.

#### 5.2.1.2 Use Case #2.2: NSI provisioning – NSaaS model

As per TS 28.530 [203] description of NSaaS, the Network Slice is considered as a Communication Service offered by a CSP to a CSC.

The CSP is the network slice provider (NSaaS provider), the CSC is the network slice customer (NSaaS consumer).

The CSC is authorized by the CSP for operations on NSI in commissioning phase/Operation phase/ Decommissioning phase.

The CSP collects charging information for the different operations performed by the CSC on Network Slices.

The potential charging requirements for this Use Case are: REQ-CH-NSIMNG-07, REQ-CH-NSIMNG-08.

### 5.2.2 Potential charging requirements

**REQ-CH-NSIMNG-01** The 5G system should support collecting charging information for NSI creation, modification and termination by CSP.

**REQ-CH-NSIMNG-02** The 5G system should support collecting charging information for NSI Activation, De-Activation by CSP.

**REQ-CH-NSIMNG-03** The 5G system should support collecting charging information for NSI creation, modification and termination by CSP for private NSI(s).

**REQ-CH-NSIMNG-04** The 5G system should support collecting charging information for NSI Activation, De-Activation by CSP for private NSI(s).

**REQ-CH-NSIMNG-05** The 5G system should support collecting charging information for NSI creation, modification and termination by CSP for shared NSI(s).

**REQ-CH-NSIMNG-06** The 5G system should support collecting charging information for NSI Activation, De-Activation by CSP for shared NSI(s).

**REQ-CH-NSIMNG-07** The 5G system should support collecting charging information for NSI creation, modification and termination by authorized CSC (NSaaS consumer).

**REQ-CH-NSIMNG-08** The 5G system should support collecting charging information for NSI Activation, De-Activation by authorized CSC (NSaaS consumer).

**REQ-CH-NSIMNG-09** The 5G system should support collecting charging information in alignment with network slice templates/attributes of service profile used for NSI creation as described in TS 28.531 [204] and TS 28.541[221].

### 5.2.3 Key issues

#### 5.2.3.1 Key issue #2.1: Network Slice management based charging – NOP model

This key issue is for investigating how to support the Network Slice management based charging for network slice instances considering REQ-CH-NSIMNG-01, EQ-CH-NSIMNG-02, REQ-CH-NSIMNG-03, REQ-CH-NSIMNG-04, REQ-CH-NSIMNG-05, REQ-CH-NSIMNG-06 and REQ-CH-NSIMNG-09.

This investigation covers the following:

- determination of which entity/entities in the management framework for 3GPP 5G system is suitable for achieving Network Slice management based charging;

- identification of the main charging information to be collected;

- possible alignment with Network Slice templates.

#### 5.2.3.2 Key issue #2.2: Network Slice management based charging – NSaaS Model

This key issue is for investigating how to support the Network Slice management based charging for network slice instances considering REQ-CH-NSIMNG-07, REQ-CH-NSIMNG-08.

This investigation covers the following:

- determination of which entity/entities in the management framework for 3GPP 5G system is suitable for achieving Network Slice management based charging;

- identification of the main charging information to be collected.

### 5.2.4 Solutions

#### 5.2.4.1 Solution #2.1: Network Slice Management based charging for Key issues #2.1

##### 5.2.4.1.1 Consideration for Network Slice Management based Charging

Based on the TS 28.530 [203] Network Slicing Management requirements, the 3GPP Management system is specified with NSI provisioning capabilities in TS 28.531 [204].

The Information Object Classes (IOC) for the Network Resource Model (NRM) definitions of network slice are defined in TS 28.541 [221] and used for NSI provisioning. Different network slice templates may be used as input to create instances of Network Slice IOC as specified in TS 28.531 [204].

Deployments models for Network Slice Management in 5G system rely on 3GPP Management system composed of Management Functions (MnF) producing and consuming Management Services (MnS), which includes NSI provisioning.

In order to focus on Management Functions and Management Services (MnS) for NSI provisioning the following terminology is retained:

- Network Slice Management Function (NSMF) is the Network Slice Management Service (NSMS) Producer.

- Network Slice Management Service (NSMS) Consumer.

##### 5.2.4.1.2 Architecture Description

This solution is based on a Charging Trigger Function (CTF) located in the NSMF.



Figure 5.2.4.1.2-1: CTF of the NSMF interacts with Converged Charging System using Nchf interface for Network Slice Management charging.

A charging service is exposed on Nchf by CHF and consumed by the NSMF.

This NSMF produces the Network slice management provisioning services defined in TS 28.531 [204] consumed by the NSMS Consumer.

##### 5.2.4.1.3 Flow Description

The NSMF represents the Network Slice Management Service (NSMS) Producer in the different diagrams.

The figure 5.2.4.1.3-1 describes the high level charging procedure for Network Slice Management – NSI creation, based on the procedure defined in clause 7.2 of TS 28.531 [204].



Figure 5.2.4.1.3-1: Charging procedure for NSI creation

1. The NSMS Consumer invokes "Create NSI" service produced by the NSMF.

2. NSI creation process.

3. The NSMF answers to NSMS Consumer with the result of NSI creation.

4-6. Charging Data Request/ Response [Event] between NSMF and CHF for the NSI creation and CDR creation

The figure 5.2.4.1.3-2 describes the high level charging procedure for Network Slice Management – NSI modification, based on the procedure defined in clause 7.6 of TS 28.531 [204].



Figure 5.2.4.1.3-2: Charging procedure for NSI modification

1. The NSMS Consumer invokes "Modify NSI" service produced by the NSMF.

2. NSI modification process.

3. The NSMF answers to NSMS Consumer with the result of NSI modification.

4-6. Charging Data Request/ Response [Event] between NSMF and CHF for the NSI modification and CDR creation

The figure 5.2.4.1.3-3 describes the high level charging procedure for Network Slice Management – NSI termination, based on the procedure defined in clause 7.4 of TS 28.531 [204].



Figure 5.2.4.1.3-3: Charging procedure for NSI termination

1. The NSMS Consumer invokes "Terminate NSI" service produced by the NSMF.

2. NSI termination process.

3. The NSMF answers to NSMS Consumer with the result of NSI termination.

4-6. Charging Data Request/ Response [Event] between NSMF and CHF for the NSI termination and CDR creation

The high level charging procedures for Network Slice Management - NSI creation and termination are similar for NSI activation and deactivation respectively. The details of TS 28.531 [204] procedures and TS 28.541 [221] NRM to be used will be addressed during the normative work.

##### 5.2.4.1.4 Solution evaluation

For this solution the advantage is:

- Different customers can have flexible and personalized network slice instance charging for NSIs operations.

- The CHF does not need to be a consumer as well as a producer of services, except for the services provided by NRF.

- The CHF can directly influence the provided service, i.e. it can grant or deny service access.

And the disadvantages are:

- Major change on 3GPP management functions, since they need to support the Nchf service.

#### 5.2.4.2 Solution #2.2: Network Slice Management based charging for Key issues #2.1 - MnS

##### 5.2.4.2.1 Consideration for Network Slice Management based Charging

See clause 5.2.4.1.1.

##### 5.2.4.2.2 Architecture Description

This solution is based on the use of NSMF producing Management service over MnS consumed by CHF.



Figure 5.2.4.2.2-1: CHF consumer of the Management Service (MnS).

This NSMF produces the Network slice management provisioning services defined in TS 28.531 [204] consumed by the NSMS Consumer over MnS.

The NSMF produces the Network slice management charging collection service consumed by the CHF over MnS, in order to achieve charging for operations on Network slice instances.

The Network slice management charging collection service is a new MnS service to be introduced.

##### 5.2.4.2.3 Flow Description

The figure 5.2.4.2.3-1 describes for this solution, the high level charging procedure for Network Slice Management – NSI operation.



Figure 5.2.4.2.3-1: Operations on NSI charging using new MnS service

1. Charging starts based on account creation for a CSP in the CHF

2. CHF subscribes to the NSMF for the "Network slice management charging collection service" for being notified of each Operation on NSIs performed by a particular CSP.

3. The NSMF confirms the subscription.

4. The NSMS Consumer (i.e. CSP) invokes an Operation on NSI (e.g. creation/activation/modification…) service produced by the NSMF.

5. Operation on NSI process is performed.

6 The NSMF answers to NSMS Consumer with the result of NSI operation.

7. The NSMF notifies the CHF with charging information for "Operation on NSI" by invoking the "Network slice management charging collection service – Notify". Information indicating whether the NSI is a shared NSI or private NSI is included.

8. A CDR is created.

##### 5.2.4.2.4 Solution evaluation

For this solution the advantage is:

- Different customers can have flexible and personalized network slice instance charging for NSI operations.

And the disadvantages are:

- Change on 3GPP management function by introduction of the new "Network slice management charging collection service".

- Change to CHF for consuming the new service.

- The CHF now needs to be a consumer as well as a producer of services, except for the services provided by NRF.

- The CHF cannot directly influence the provided service, i.e. it cannot grant or deny service access.

#### 5.2.4.3 Solution #2.3: Network Slice Management based charging for Key issues #2.2 - CTF

##### 5.2.4.3.1 Consideration for Network Slice Management based Charging

The TS 28.530 [203] Network Slicing Management requirements includes an Exposure of network slice management capability, and the 3GPP Management system is specified with Provisioning exposure for NSI capabilities in clause 6.1 of TS 28.531 [204].

A deployment model in TS 28.533 [206], clause A.3 Utilization of management services by Exposure Governance Management Function (EGMF) is considered for this solution.

In order to focus on Management Functions and Management Services (MnS) for Provisioning exposure for NSI capabilities the following terminology is retained:

- Exposure Governance Management Function (EGMF) is the Network Slice Management Service (NSMS) Producer.

- Network Slice Management Service (NSMS) Consumer.

##### 5.2.4.3.2 Architecture Description

This solution is based on a Charging Trigger Function (CTF) located in the EGMF.



Figure 5.2.4.3.2-1: CTF of the EGMF interacts with Converged Charging System using Nchf interface for Network Slice Management charging.

A charging service is exposed on Nchf by CHF and consumed by the EGMF.

This EGMF produces the Network slice management provisioning services defined in TS 28.531 [204] consumed by the NSMS Consumer.

##### 5.2.4.3.3 Flow Description

The flow description is the same as in clause 5.2.4.1.3 with the NSMF replaced by the EGMF.

##### 5.2.4.3.4 Solution evaluation

For this solution the advantage is:

- Different customers can have flexible and personalized network slice instance charging for NSIs operations.

- The CHF does not need to be a consumer as well as a producer of services, except for the services provided by NRF.

- The CHF can directly influence the provided service, i.e. it can grant or deny service access.

And the disadvantages are:

- Major change on 3GPP management functions, since they need to support the Nchf service.

#### 5.2.4.4 Solution #2.4: Network Slice Management based charging for Key issues #2.2 - MnS

##### 5.2.4.4.1 Consideration for Network Slice Management based Charging

See clause 5.2.4.3.1.

##### 5.2.4.4.2 Architecture Description

This solution is based on the use of EGMF producing Management service over MnS consumed by CHF.

The same architecture as figure 5.2.4.2.2-1 with NSMF replaced by EGMF.

##### 5.2.4.4.3 Flow Description

The flow description is the same as in clause 5.2.4.2.3 with the NSMF replaced by the EGMF.

##### 5.2.4.4.4 Solution evaluation

Same evaluation as clause 5.1.4.2.4.

#### 5.2.4.5 Solution #2.5: Communication Service using Network Slice Management based charging for Key issues #2.1

##### 5.2.4.5.1 Consideration for Network Slice Management based Charging

Based on the TS 28.530 [203] Network Slicing Management requirements, the 3GPP Management system is specified with NSI provisioning capabilities in TS 28.531 [204]. The management of network slicing when used as communication services are studied in TR 28.805 [251].

In the study the CSMF receives all information about creation, activation, deactivation and termination of a CSI from the Order care that it needs. This means that all relevant charging information will be in the Order care and in this case charging or billing could interface directly with Order care. The interaction with Order care from a charging perspective would be considered outside the scope of the current study.

### 5.2.5 Evaluation

#### 5.2.5.1 Solutions evaluation for Key issue# 2.1

Both solutions #2.1 and #2.2 solve Key issue #2.1.

In the solution #2.2 the CHF becomes a consumer of services (beyond the services provided by NRF), which deviates from how CHF functionality is currently designed.

The **s**olution #2.1 has the advantage of being futureproof from charging's perspective since it allows influence on the provided service, i.e. it cannot grant or deny service access, which is not the case in solution #2.2.

#### 5.2.5.2 Solutions evaluation for Key issue# 2.2

Both solutions #2.3 and #2.4 solve Key issue #2.2.

In the solution #2.4 the CHF becomes a consumer of services (beyond the services provided by NRF), which deviates from how CHF functionality is currently designed.

The solution #2.3 has the advantage of being futureproof from charging's perspective since it allows influence on the provided service, i.e. it cannot grant or deny service access, which is not the case in solution #2.3.

### 5.2.6 Conclusions

It is concluded on:

- Solution#2.1 for Key issue #2.1.

- Solution#2.3 for Key issue #2.2.

## 5.3 Topic 3: Business to Consumer

### 5.3.1 Use Case

#### 5.3.1.1 Use Case #3.1: Consumer consumes communication services

The NOP/CSP provides communication services using different network slice instances.

Consumer subscribes the services with specific requirements. UE establishes PDU session to access the services in the specific NSI. The NOP/CSP collects charging information and/or performs credit control per UE per PDU session.

The NOP/CSP is the service provider to provide communication services using different NSIs.

The potential charging requirements for this UC are: REQ-3GPPCH-X1 and REQ-3GPPCH-X2.

### 5.3.2 Potential charging requirements

**REQ-3GPPCH-X1** The 5G system should support collecting charging information of service using NSIs.

**REQ-3GPPCH-X2** The 5G system should support perform credit control for service consumption using NSIs.

### 5.3.3 Key issues

#### 5.3.3.1 Key issue #3.1: Usage based charging related to the specific NSI

This key issue is for investigating how to support the usage based charging related to the S-NSSAI considering REQ-3GPPCH-X1 and REQ-3GPPCH-X2.

This investigation covers the following:

- identification of the usage type used for usage based charging related to the S-NSSAI;

- determination of which entity/entities in the 5G system is suitable to provide the usage information;

- how to perform credit control for service usage related to the specific S-NSSAI.

### 5.3.4 Solutions

#### 5.3.4.1 Solution #3.1: Usage based charging for Key issues #3.1

##### 5.3.4.1.1 Consideration for usage based charging

For consumer, service delivery related usage type may include following:

- volume;

- duration (per PDU session).

The NOP may collect usage information and/or perform credit control of above unit types for consumer per PDU session.

According to the SMF capabilities specified in TS 32.255 v15.1.0 [15], the SMF can collect and provide the above charging information per PDU session of S-NSSAI. Therefore, the SMF can act as CTF for usage based charging related to the specific S-NSSAI.

##### 5.3.4.1.2 Architecture Description

The converged online and offline charging architecture is adapted for the usage based charging related to network slice instances.



Figure 5.3.4.1.2-1: The Converged Charging System

The SMF requests quota from CHF and consumes quota for service delivery, and/or reports the usage information of network slice instances per PDU session.

##### 5.3.4.1.3 Flow Description

The same message flow to specify the interaction between the SMF and the CHF for 5G data connection in different scenarios in clause 5.2.2 of TS 32.255 [15].

##### 5.3.4.1.4 Solution evaluation

In this solution, there is no impact on existing Nchf between SMF and CHF.

### 5.3.5 Evaluation

#### 5.3.5.1 Solutions evaluation for Key issue# 3.1

Solution #3.1 solves the Key issue #3.1.

The solution #3.1 has no impact on existing Nchf between SMF and CHF.

### 5.3.6 Conclusions

It is concluded for Key issue # 3.1 as per solution #3.1 in clause 5.3.4.1, and no further normative work.

## 5.4 Topic 4: Business to Business to X (B2B2X)

### 5.4.1 General

Each of the parts of the business models B2B2X (e.g. B2B, B2C, etc) described in TS 28.530 [203] are already covered in this study.

# 6 Conclusions and Recommendations

The conclusion for identified key issues are:

- Performance and Analytics based charging: solutions as per clause 5.1.6 conclusion.

- Usage based charging: solutions as per clause 5.1.6 conclusion.

- Capacity based network slice charging: solutions as per clause 5.1.6 conclusions.

- Network Slice management: solutions as per clause 5.2.6 conclusion.

- Network slice charging for Business to Consumer: solutions as per clause 5.3.6 conclusion.

The charging architecture and charging information is recommended to be specified at normative phase.

# Annex A: Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2018-11 | SA5 #122 | S5‑187187  S5-187448  S5-187449 |  |  |  | Update of the Skeleton  Scope  Update of the Reference | 0.1.0 |
| 2019-01 | SA5 #123 | S5-191401  S5-191318  S5-191319  S5-191320  S5-191321  S5-191322  S5-191323 |  |  |  | Addition of the References and Abbreviations  Introduce the Network Slicing Related Concept  Introduce the Roles related Network Slicing  Addition of Charging Aspect Requirements  Addition of Use Case and Potential Charging Requirements  Addition of Key Issues and Solution for Usage based Charging  Addition of Key Issues and Solution for SLA based Charging | 0.2.0 |
| 2019-03 | SA5 #124 | S5-192290  S5-192291  S5-192292  S5-192293  S5-192295 |  |  |  | Addition of solution evaluation for solution #1.1  Addition of solution for event based charging  Addition of Use Case about Network Slice Subscription  Solution to Performance based Charging  Addition of a few editorial corrections and many clarifications between NW | 0.3.0 |
| 2019-04 | SA5 #125 | S5-193335  S5-193336  S5-193337  [S5-193069](http://www.3gpp.org/ftp/TSG_SA/WG5_TM/TSGS5_125/Docs/S5-193069.zip)  S5-193338 |  |  |  | Addition of solution for NSI Performance Charging  Addition of solution evaluation for solution #1.4  Clarify the interaction with management system  Clarify the Network slice instance charging  Clarification of aggregation for NSI Charging | 0.4.0 |
| 2019-06 | SA5 #125Ad | [S5-194107](http://www.3gpp.org/ftp/TSG_SA/WG5_TM/TSGS5_125AH/Docs/S5-194107.zip)  S5-194344  S5-194345  S5-194346  S5-194347  [S5-194052](http://www.3gpp.org/ftp/TSG_SA/WG5_TM/TSGS5_125AH/Docs/S5-194052.zip)  S5-194348  S5-194349  S5-194350  S5-194352  S5-194353  S5-194354 |  |  |  | Modify the key issues for requirement 6  Clarify on the performance data and capacity  Clarify on the performance data and KPI  New topic - Network Slice Management  Network Slice Management charging – solution  Network Slice Management charging - Key Issue  Addition of solution evaluation and conclusion for usage based charging  Addition of use case and potential charging requirements for B2B  Key issues and solution for usage limit  Add a new topic for Business to Consumer (B2C)  Performance based charging - NWDAF solution  Harmonizing the Solution evaluations | 0.5.0 |
| 2019-08 | SA5 #126 | S5-195151  S5-195598  S5-195599  S5-195600  S5-195601  S5-195602  S5-195604  S5-195605  S5-195606  S5-195607  S5-195608  S5-195609  S5-195610  S5-195611  S5-195612  S5-195613  S5-195614  S5-195615  S5-195713  S5-195714 |  |  |  | Solutions for Key issue #2.2  Solve Editor's note on Business Roles  Use of MnS for performance data and architecture implications  Use of MnS by NWDAF for performance data  Use of NWDAF for Load - evaluation  Solutions evaluation for Key issue #1.1  Introduce flows for NSI Operations  New topic 2 use cases - shared and private NSI  Solution #2.1 - evaluation  New Solution for Key issue #2.1  Solution for Communication Service using Network Slice  New topic 2 use case NSaaS  Add new potential charging requirement for Topic 2  Update to Use Case 1.4 to address non-performance related attributes  Add new potential charging requirements for Topic 1  New key issue for Topic 1 - Template Based Charging  Updates to address Template Based Charging  New topic about Business to Business to X  Add the solution evaluation for performance based charging  Solutions evaluation for topic 2 | 0.6.0 |
| 2019-09 | SA#85 | SP-190776 |  |  |  | Presented for information | 1.0.0 |
| 2019-10 | SA5 #127 | S5-196549  S5-196550  S5-196551  S5-196552  S5-196553 |  |  |  | Conclusion on Business to Consumer  Conclusion on event based charging  Conclusion on solution 1.6  Relocate the conclusion of topic 1  Correction on the editorial Comments | 1.1.0 |
| 2019-11 | SA5#128 | S5-197525 S5-197526 |  |  |  | Remove the editor's note about capacity based charging  Conclusion of the study | 1.2.0 |
| 2019-12 | SA#86 | SP-191184 |  |  |  | Presented for approval | 2.0.0 |
| 2019-12 | SA#86 |  |  |  |  | Change control version | 16.0.0 |